The Effect of Adding Antimony Trioxide (Sb_2O_3) On A.C Electrical Properties of (PVA-PEG) Films

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Abstract

In this work, many samples have been prepared by adding Antimony Trioxide (Sb_2O_3) to the polyvinyl alcohol-poly ethylene glycol (PVA-PEG). The effect of the Sb_2O_3 added as a filler with different weight percentages on the A.C electrical properties have been investigated. The samples were prepared as films by solution cast technique. The experimental results of the A.C electrical properties show that the dielectric constant increase with the increasing frequency of applied electrical field and concentration of the Antimony Trioxide. Dielectric loss decrease with the increasing the frequency, while it increases with the increase of the concentration of the Antimony Trioxide. The A.C electrical conductivity increase with increasing the Antimony Trioxide contain and frequency for the composition.

Keywords: A.C Electrical properties, Composite, Polyvinyl alcohol, Poly ethylene glycol, Antimony Trioxide.

الخلاصة

في هذا العمل، تم تحضير العديد من العينات عن طريق إضافة أكسيد الأنتيمون إلى بولي فينيل الكحول و بولي إيثلين كلايكول و دراسة تأثير إضافة أكسيد الأنتيمون كمادة مالئة مع نسب وزنية مختلفة على الخواص الكهربائية المتناوبة حيث تم تحضير العينات بشكل اغشية بواسطة تقنية الصب. أظهرت النتائج التجريبية للخصائص الكهربائية المتناوبة أن ثابت العزل الكهربائي يزداد مع زيادة تردد المجال الكهربائي المسلط وزيادة تركيز ثلاثي اوكسيد الأنتيمون, وايضا ان الفقدان العزلي يقل مع زيادة التردد ، في حين أنه يزداد مع زيادة تركيز ثلاثي اوكسيد الأنتيمون . وان الموصلية الكهربائي المتناوبة تزداد مع زيادة محتوى ثلاثي الأكسيد الأنتيمون والتردد للمركب.

الكلمات المفتاحية: الخصائص الكهربائية المتناوبة ، مركب، كحول بولي فينيل، بولي جلاي كول الإيثلين، ثلاثي أكسيد الأنتيمون.

Introduction

Polymer composites have steadily gained growing importance during the past decade. A great interest has been explored in the field of conductive and Semi conductive polymeric materials due to the fast progress in the molecular applications, these researches have been made to obtain a new polymeric materials with enhanced specific properties for specific application or better combination of different properties(Lei Ma *et al.*, 2007). Active developments of polymer composite and extensive use of polymer materials in technology have led to the polymer composites.

The importance of polymers are primarily because polymers are still considered as a cheap alternative material that is manufactured easily. The intensive use of polymer has led to the development of materials for specific applications (Devikala *et al.*, 2013). The main advantages of polymer electrolytes are their mechanical properties, ease of fabrication of thin films of desirable sizes and their ability to form proper electrode/electrolyte contact in electrochemical devices (Sasikala, 2012) .

PVP is an amorphous polymer of high environmental stability, easy process ability, and moderate thermal conductivity (Ahmad and Sheha, 2013). PVA is one of

the earliest and best known polymers, it was seen to use in a variety of applications and is currently used extensively in semiconductors applications (Al–Adamand H. A, 1983). PEG explain the high solubility in water on the basis that the polymer has the ability to fit in the water network more easily than other polymers (Rabee and Hadi, 2014). The advantage of PVA and PEG that have the ability to blend into the water which is resistant to do solvents, oils, and have the ability exceptional adhesion materials cellulosic so use wide are used in making paper and textile industries in the manufacture of membranes resistance to oxygen in the coating photographic film (James, 1998) The present study is focused on the effect of Antimony Trioxide additive on the A.C electrical properties of polyvinyl alcohol-poly ethylene glycol films.

Experimental and Theoretical Work

The materials which are used in this research are polyvinyl alcohol- poly ethylene glycol as a matrix and Antimony trioxide powder as filler. The weight percentages of the Antimony trioxide are (2 and 4) wt.% were add to the PVA 80 wt.% and PEG 20wt.% that dissolved in distilled water by using magnetic stirrer for the mixing process (35 minutes) with temperature (67 ^{o}C) then wait for (10 minutes) to get mixture more homogenous using casting technique to preparation the films from this mixture. Casting each one of these ratios in 5 × 5 cm^2 glass petri dish and then left for (6 days) to dry at room temperature. The film thickness are found to be (1.5 μm) measured by digital micrometer. The A.C electrical properties for the (PVA-PEG-Sb_2O_3) films were studied using LCR meter within frequency range (100 Hz to 5 MHz) at room temperature. The dielectric constant (ε'), which is the most important A.C properties, was calculated by using the equation (1) which gives the ratio of the capacitance of a dielectric-filled capacitor (C_p) to a capacitor of free space (C_o) (Kittel, 2005):

$$\varepsilon' = C_p/C_o \qquad (1)$$

The dielectric loss (ε'') was calculated by equation (2) using the measured dielectric constant and tan δ (Kittel C., 2005):

$$\varepsilon'' = \varepsilon' \times \tan\delta \qquad (2)$$

where tan δ is dissipation factor .

The A.C electrical conductivity ($\sigma_{a.c}$) was calculated by equation (3) after substituting the measured values of ε'

$$\sigma_{a.c} = \omega\varepsilon_o\varepsilon'' \qquad (3)$$

where (ω) is the angular frequency, (ε_o) is permittivity of free space, ($\sigma_{a.c}$) represents the A.C conductivity of the polymer sample which arises from the motion of charge carriers through the polymer (Hamzah M. et al, 2008).

Results and Discussion

Figure (1) illustrates the relationship between the dielectric constant of (PVA-PEG-Sb_2O_3) films with the frequency. The figure illustrates that the dielectric constant is decreases with increasing of applied field frequencies, this is according to the decreasing of space charge polarization to the total polarization. The space charge polarization becomes the more contributing type of polarization at low frequencies, and less contributing with the increase of frequency, therefore dielectric constant values would decreases with increase of the electric field frequency for the prepared samples (Ahmed and Zihilif, 1992). As well as, we can note the dielectric constant of (PVA-PEG-Sb_2O_3) film was increased with increasing of the weight percentages of the Antimony trioxide concentrations as illustrates in the figure (2), which due to

increase the carriers of charge and also formation of a continuous network of Antimony Trioxide (Maher, 2013)

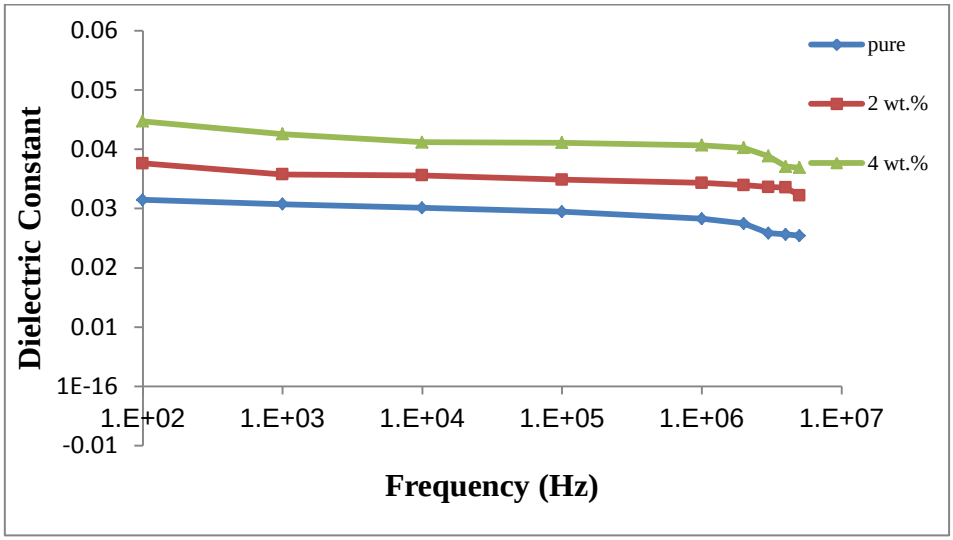

Figure (1): The variation of the dielectric constant of (PVA-PEG- Sb_2O_3) films with the frequency.

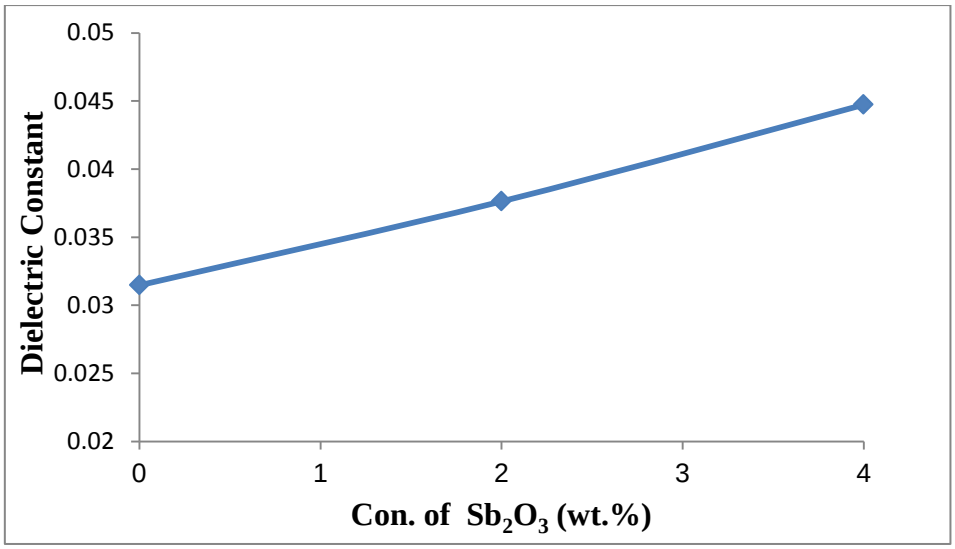

Figure (2): The variation of the dielectric constant of (PVA-PEG- Sb_2O_3) films with various concentrations of Antimony Trioxide.

Figure (3) illustrates the relationship between the dielectric loss of (PVA-PEG-Sb_2O_3) films with the frequency. From this figure illustrates that the dielectric loss decreases with the increasing the applied field frequencies which attributed to the decreases of the space charge polarization. On the other hand, we can note the dielectric loss of (PVA-PEG-Sb_2O_3) films increases with increasing of the weight percentages of the Antimony trioxide, this is according to increase the numbers of electrons, which is increase the electrical conductivity of polymer matrix (Bhattacharya and Bhowmick , 2008) as shown in figure (4).

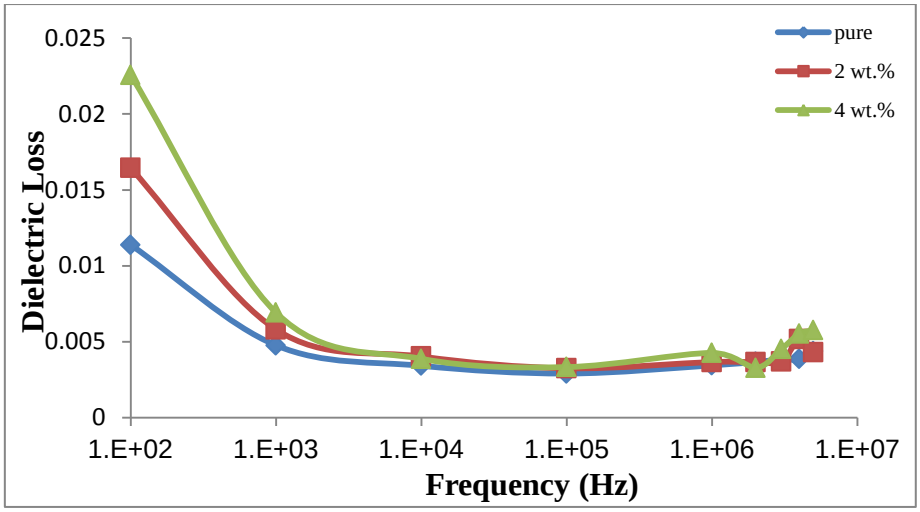

Figure (3): The variation of the dielectric loss of (PVA-PEG- Sb_2O_3) films with the frequency.

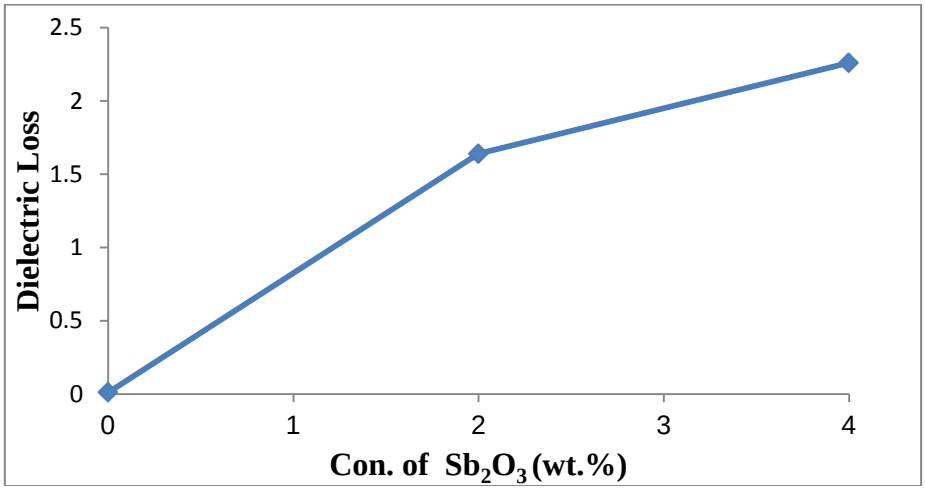

Figure (4): The variation of the dielectric loss of (PVA-PEG-Sb_2O_3) films with various concentration of Antimony Trioxide.

The variation of A.C electrical conductivity of (PVA-PEG-Sb_2O_3) films as a function of frequency is illustrates in figure (5). The A.C electrical conductivity is increase with increasing of the frequency, this is according to the electronic polarization and the charge carriers which travel by hopping (Vishnuvardhan T. K et al., 2006). On the other hand, the A.C electrical conductivity is increased with increasing of the concentration of Antimony trioxide,(more clearly in finger (6)), which attributed to increase the numbers of charge carries(Vishnuvardhan *et al.*, 2006).

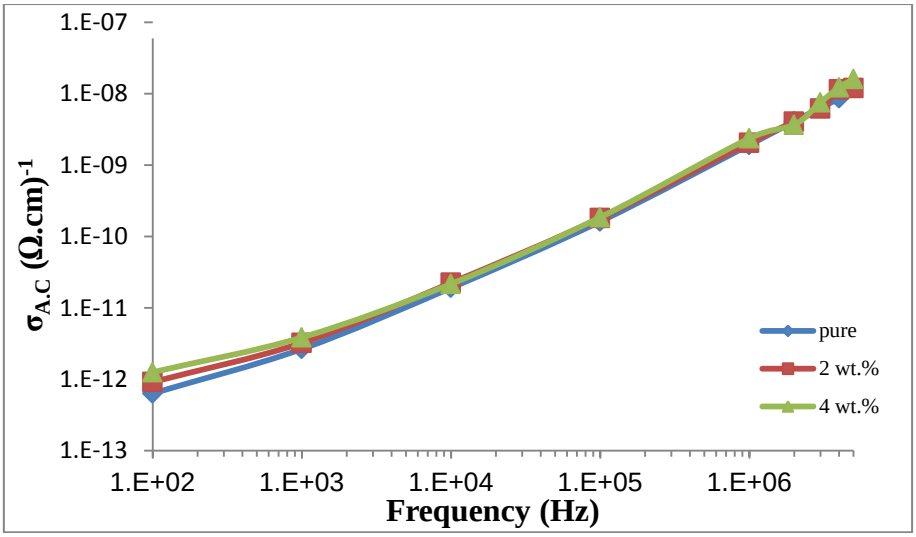

Figure (5): The variation of the Electrical Conductivity of (PVA-PEG- Sb_2O_3) films with the frequency.

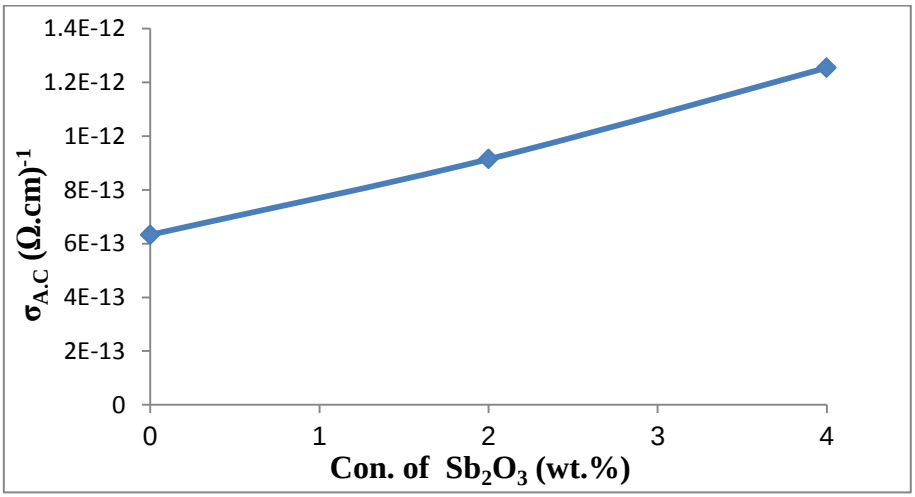

Figure (6): The variation of A.C electrical conductivity for (PVA-PEG-Sb_2O_3) films with various concentration of Antimony Trioxide.

4 .Conclusions

The dielectric constant for the (PVA-PEG-Sb_2O_3) films are declines trend as increasing of the frequency while it increases with increasing of the Sb_2O_3 concentrations. The dielectric loss of the films are declining trend as increasing of the frequency and it increases with increasing of the weight percentages of Sb_2O_3 concentrations. The A.C electrical conductivity values of the films are increasing with the increasing of the frequency and concentrations of Sb_2O_3.

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